



August 23, 2011

L-PI-11-077
10 CFR 50.73

U S Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Prairie Island Nuclear Generating Plant Unit 1
Docket: 50-282
Renewed License No. DPR-42

LER 50-282/2011-002-00, Unit 1 Reactor Manually Tripped In Response to An
Inadvertent Turbine Stop Valve Closure

Northern States Power Company, a Minnesota corporation (NSPM), doing business as Xcel Energy, herewith encloses Licensee Event Report (LER) 50-282/2011-002-00.

On July 1, 2011, Prairie Island Nuclear Generating Plant (PINGP) Unit 1 was manually tripped from approximately 100% steady-state power. The manual reactor trip was in response to the right main turbine stop valve failing closed as the result of an Electro-Hydraulic (EH) oil leak located at the stop valve. As designed, 11 and 12 Auxiliary Feed Water (AFW) pumps auto started on steam generator low water level.

The causal evaluation determined that right main turbine stop valve failed closed due to excessive oil leakage from a failed O-ring. An age related compression set and slight extrusion near the outside contact surface resulted in the failed O-ring.

Summary of Commitments

This letter contains no new commitments and no changes to existing commitments.

A handwritten signature in black ink, appearing to read 'Mark A. Schimmel'.

Mark A. Schimmel
Site Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company - Minnesota

Enclosure

cc: Administrator, Region III, USNRC
Project Manager, Prairie Island Nuclear Generating Plant (PINGP), USNRC
Resident Inspector, PINGP, USNRC
Department of Commerce, State of Minnesota

ENCLOSURE

LICENSEE EVENT REPORT 50-282/2011-002-00

4 Pages Follow

LICENSEE EVENT REPORT (LER)(See reverse for required number of
digits/characters for each block)

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects.resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0068), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

1. FACILITY NAME

Prairie Island Nuclear Generating Plant Unit 1

2. DOCKET NUMBER

05000 282

3. PAGE

1 OF 4

4. TITLE

Unit 1 Reactor Manually Tripped In Response to An Inadvertent Turbine Stop Valve Closure

5. EVENT DATE

MONTH	DAY	YEAR
07	01	2011

6. LER NUMBER

YEAR	SEQUENTIAL NUMBER	REV NO
2011	002	00

7. REPORT DATE

MONTH	DAY	YEAR
08	23	2011

8. OTHER FACILITIES INVOLVED

FACILITY NAME	DOCKET NUMBER
FACILITY NAME	DOCKET NUMBER

9. OPERATING MODE

Mode 1

10. POWER LEVEL

100%

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)

- | | | | |
|---|---|--|---|
| <input type="checkbox"/> 20.2201(b) | <input type="checkbox"/> 20.2203(a)(3)(i) | <input type="checkbox"/> 50.73(a)(2)(i)(C) | <input type="checkbox"/> 50.73(a)(2)(vii) |
| <input type="checkbox"/> 20.2201(d) | <input type="checkbox"/> 20.2203(a)(3)(ii) | <input type="checkbox"/> 50.73(a)(2)(ii)(A) | <input type="checkbox"/> 50.73(a)(2)(viii)(A) |
| <input type="checkbox"/> 20.2203(a)(1) | <input type="checkbox"/> 20.2203(a)(4) | <input type="checkbox"/> 50.73(a)(2)(ii)(B) | <input type="checkbox"/> 50.73(a)(2)(viii)(B) |
| <input type="checkbox"/> 20.2203(a)(2)(i) | <input type="checkbox"/> 50.36(c)(1)(i)(A) | <input type="checkbox"/> 50.73(a)(2)(iii) | <input type="checkbox"/> 50.73(a)(2)(ix)(A) |
| <input type="checkbox"/> 20.2203(a)(2)(ii) | <input type="checkbox"/> 50.36(c)(1)(ii)(A) | <input checked="" type="checkbox"/> 50.73(a)(2)(iv)(A) | <input type="checkbox"/> 50.73(a)(2)(x) |
| <input type="checkbox"/> 20.2203(a)(2)(iii) | <input type="checkbox"/> 50.36(c)(2) | <input type="checkbox"/> 50.73(a)(2)(v)(A) | <input type="checkbox"/> 73.71(a)(4) |
| <input type="checkbox"/> 20.2203(a)(2)(iv) | <input type="checkbox"/> 50.46(a)(3)(ii) | <input type="checkbox"/> 50.73(a)(2)(v)(B) | <input type="checkbox"/> 73.71(a)(5) |
| <input type="checkbox"/> 20.2203(a)(2)(v) | <input type="checkbox"/> 50.73(a)(2)(i)(A) | <input type="checkbox"/> 50.73(a)(2)(v)(C) | <input type="checkbox"/> OTHER |
| <input type="checkbox"/> 20.2203(a)(2)(vi) | <input type="checkbox"/> 50.73(a)(2)(i)(B) | <input type="checkbox"/> 50.73(a)(2)(v)(D) | Specify in Abstract below or in NRC Form 366A |

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER (Include Area Code)
Sam J. DiPasquale, P.E.	651.388.1121 x7350

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
B	TG	SEAL	0000	Y					

14. SUPPLEMENTAL REPORT EXPECTED☐ YES (If yes, complete 15. EXPECTED SUBMISSION DATE). ☒ NO**15. EXPECTED SUBMISSION DATE**

MONTH	DAY	YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

On July 1, 2011, Prairie Island Nuclear Generating Plant (PINGP) Unit 1 was manually tripped from approximately 100% steady-state power. The manual reactor trip was in response to the right main turbine stop valve failing closed as the result of an Electro-Hydraulic (EH) oil leak located at the stop valve. As designed, 11 and 12 Auxiliary Feed Water (AFW) pumps auto started on steam generator low water level.

The causal evaluation determined that right main turbine stop valve failed closed due to excessive oil leakage from a failed O-ring. An age related compression set and slight extrusion near the outside contact surface resulted in the failed O-ring.

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EVENT DESCRIPTION

On July 1, 2011 at approximately 15:52 CDT, Prairie Island Nuclear Generating Plant (PINGP) Unit 1 was manually tripped from approximately 100% steady-state power. The manual reactor trip was in response to CV-31183, the right (south) steam turbine¹ Right Stop Valve (RSV)² failing closed as the result of an Electro-Hydraulic³ (EH) oil leak located at the RSV. As designed, 11 and 12 Auxiliary Feed Water⁴ (AFW) pumps auto started on steam generator⁵ low water level.

The PINGP Unit 1 turbine-generator consists of a steam turbine that drives an electrical generator⁶. High-pressure steam enters the turbine through two turbine stop valves and four governing valves. One turbine main steam stop and two main steam governing valves form a single assembly. An electro-hydraulic (EH) actuator controls each turbine stop valve so that it is either in the wide-open or closed position. The stop valve has a hydraulic cylinder equipped with a test port blank flange sealed with an O-ring⁷.

Timeline:

July, 1997	Actuator was rebuilt
October, 2009	Unit 1 Control Valve and Stop Valve Actuators replaced during 1R26 (Unit 1 refueling outage, Cycle 26)
December, 2009	Noted small oil leakage from Right Stop Valve (RSV) CV-31183 actuator and scheduled repair for 1R28
April, 2011	Unit 1 operated without any significant issues involving the RSV for the operating cycle (October, 2009 – April, 2011)
April –June, 2011	1R27 - Performed Left Stop Valve work, no work done with or to the RSV
June 11, 2011, approximately 00:38 CDT	Unit 1 in Mode 1, end of 1R27
July 1, 2011, approximately 15:52 CDT	RSV failed shut resulting in a Unit 1 manual Reactor trip

Post-trip investigation determined that there was an EH system leak at the RSV. The leak was determined to have originated from the back side of the Actuator. The test port flange O-Ring seal was found failed. A new O-Ring was installed and Unit 1 entered Mode 1 at 17:03 CDT on July 2, 2011.

¹ EIS System Code: TA
² EIS Component Identifier: ISV
³ EIS System Code: TG
⁴ EIS System Code: BA
⁵ EIS Component Identifier: SD
⁶ EIS System Code: TB
⁷ EIS Component Identifier: SEAL

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EVENT ANALYSIS

The Stop Valve and Control Valve actuators are replaced on a nominal ten year frequency. The last known rebuild of the RSV actuator was in 1997 by J. M Grimstad Inc. This actuator remained in the warehouse for approximately twelve years until it was installed during 1R26 in October, 2009. It was in service for less than two years before the O-ring failed.

On December 8, 2009, (soon after the 1R26 outage) a Work Request (WR) was initiated due to oil leakage from the RSV actuator. This WR was converted to Work Order (WO) and scheduled for 1R28 (along with other major valve assembly work). It was not recognized that the slight leakage could have been a precursor to the RSV O-ring failure. Unit 1 had operated without any significant issues involving the RSV for the operating cycle (October, 2009 – April, 2011). No work was scheduled during 1R27 involving the known actuator leakage. Unit 1 was placed in Mode 1 on June 11, 2011 at 00:38 CDT. The RSV O-ring failed requiring a manual Reactor trip at 15:52 CDT on July 1, 2011,

Prior to disassembly, the as found torque values were recorded. Values of 50, 200, 250 and 375 in-lbs were recorded. The lowest values were recorded on the side the O-ring failed on. The O-ring condition was inspected and there was a crack all the way through the cross section. Additionally, the O-ring had a split along the outer circumference that propagated approximately 90 degrees of the circumference. The O-ring also showed signs that a bursting phenomena occurred. The O-ring was found to be pliable and capable of being tightly bent 180 degrees about itself without showing any signs of distress.

Since the pressure force for this O-ring is on the inside radius, a careful inspection of the inside radius was performed. No evidence of nicks, cuts, abrasion or foreign material were observed that indicate the initiating point of the failure was from the inside surface of the O-ring. From the inspection, failure initiation appears to be from the outside surface.

The inspection identified two primary issues. First, the O-ring was flattened somewhat. There was not enough flattening to classify it as a true compression set however, this flattening was an abnormal indication. This flattening is most likely age induced deformation of the O-ring. Second, the O-ring shows slight signs of extrusion on the low pressure edge. Extrusion occurs when an O-ring is squeezed into the gap between the metal surfaces. The observed extrusion is not as pronounced as in the industry literature. However, a slight extrusion is apparent. This can be caused by excessive clearances, excessive pressure, improper sizing, etc. Inspecting the origin of the failure indicates the initiation point for the O-ring failure is at the observed extrusion location. Extrusion of this type caused a stress concentration and appears to ultimately have caused the leakage with CV-31183.

The manual Reactor trip is reportable under 10 CFR 50.73(a)(2)(iv)(A) since there was a manual actuation of the Reactor Protection⁸ system (RPS). During the transient, Steam Generator water level went low (as expected) and the auxiliary feedwater system (AFW) actuated (as designed). The autostart of the AFW system is also reportable under 10 CFR 50.73(a)(2)(iv)(A).

⁸ EIS System Code: JC

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SAFETY SIGNIFICANCE

This event did not challenge nuclear safety as all plant systems responded as designed. Therefore, this event does not represent a safety system functional failure for Unit 1. However, the O-ring failure resulted in the RSV failing closed and required the operators to manually trip the Reactor. This initiating event challenged reliable operation and any unplanned reactor trip is a significant event. The plant systems responded as designed so there were no radiological, environmental, or industrial impacts associated with this event. Therefore, this event did not affect the health and safety of the public.

CAUSE

The causal evaluation determined that right main turbine stop valve failed closed due to excessive oil leakage from a failed O-ring. An age related compression set and slight extrusion near the outside contact surface resulted in the failed O-ring.

The compression set caused the O-ring to behave differently inside the groove. The slight extrusion condition causes stress concentration at that location. Combined with the slightly less torque values found on the failure location side, the O-ring failed and ultimately burst causing excessive leakage and the RSV to fail closed.

A contributing cause was that actuators do not have serial numbers to allow for tracking. Additionally, no tracking mechanism exists for spare turbine control actuators resulting in the installation of an actuator that had been last rebuilt in 1997.

CORRECTIVE ACTION

A review of the past actuator replacements will be conducted to determine if proactive O-ring replacement is warranted. WR(s) will be initiated as necessary to perform replacements.

Preventive Maintenance (PM) procedures will be revised to ensure that the O-rings on the Stop Valves and Control Valves are replaced when the actuators are replaced. This approach makes the contributing cause involving serial number tracking irrelevant.

The proper cap screw torque value(s) will be determined and evaluated.

PREVIOUS SIMILAR EVENTS

A LER search was conducted and no similar events involving age-related failures of O-rings were identified in the last three years at PINGP.